Session 101
Life Cycle Power Consumption
HDD Vs. SSD

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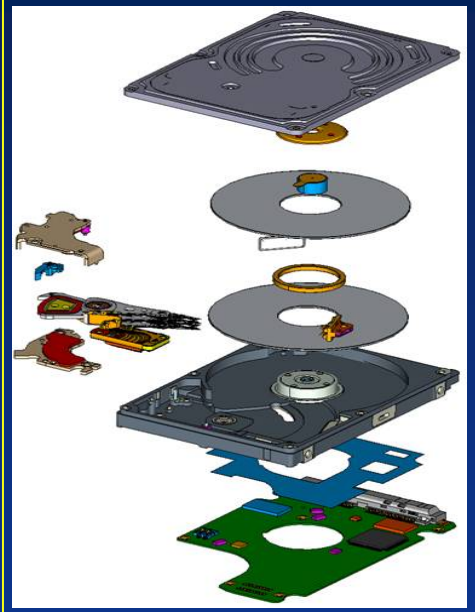
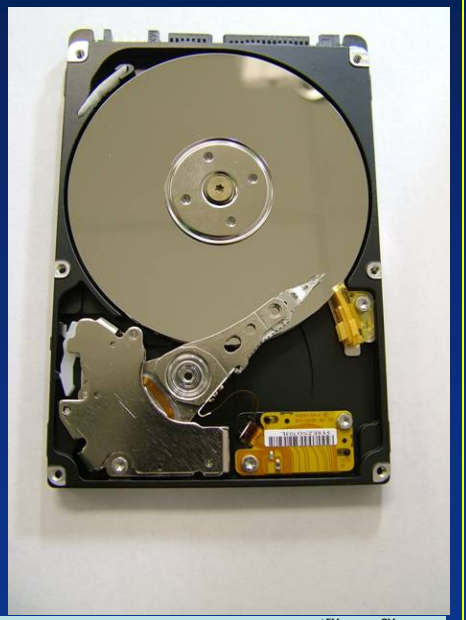
AGENDA

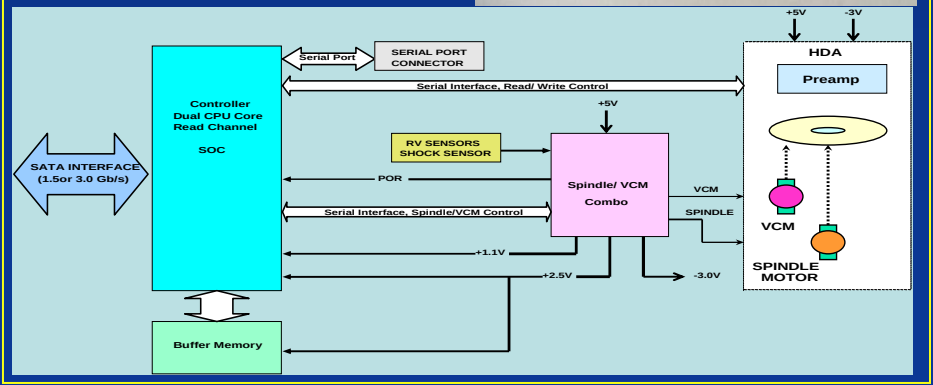
- Brief Description of HDD and SSD
- Major energy consuming steps
- Energy spent during the life of HDD and SSD
- Work load based power usage of HDD and SSD
- Directions for energy efficiency
- Concluding remarks

Description of HDD Vs. SSD

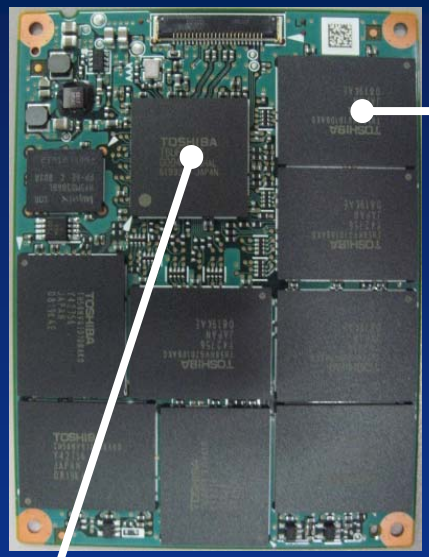
HDD

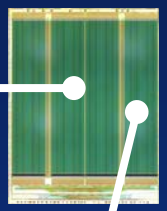


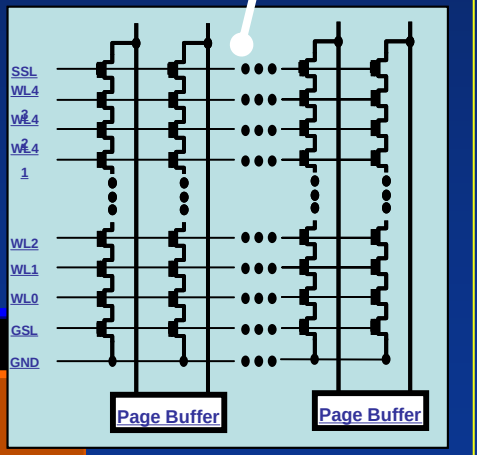


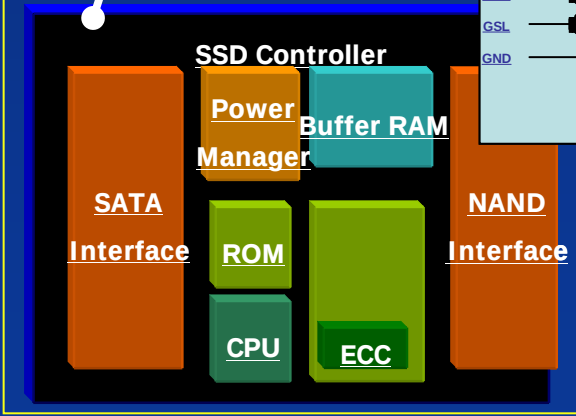


SSD









Energy Consumption in HDD Life

- Design Considerations
  - # of disks, rpm, disk diameter, data rate, css or lul, SOC line width, Seek profile, Helium or air, Spin up time trade off with starting power, work load management plan (firmware), power management strategy
- Key Components
  - Head, disk, motor, hda, soc, pcba
- Assembly & Test
  - Cleaning, servo pattern writing, burn in, tests
- Utilization
  - Duty cycle, seek profile, command execution path, background operations
- Data Recovery
  - Rework
  - Data transfer from one drive to another
- Recycling
  - Energy to convert drive into recycled product

Energy Consumption in SSD Life

- Design Considerations
  - # of Channels (buses) to NAND, Channel speed (40MB/s, 80MB/s, 133MB/s …), # of NAND sharing a Channel, # of total NAND, Process technology (5x, 4x, 3x, 2x nm) for NAND manufacturing, Super-cap or battery backup, work load management plan (firmware), power management strategy
- Key Components
  - NAND, soc, pcba
- Assembly & Test
  - Multi-chip packaging of NAND dies, Multi-package stacking of NAND, tests
- Utilization
  - Duty cycle, hot / cold data management, command execution path, background operations, Preventive monitoring of NAND blocks, Bad block replacement, ECC
- Data Recovery
  - Rework
  - Data transfer from one drive to another
- Recycling
  - Energy to convert drive into recycled product

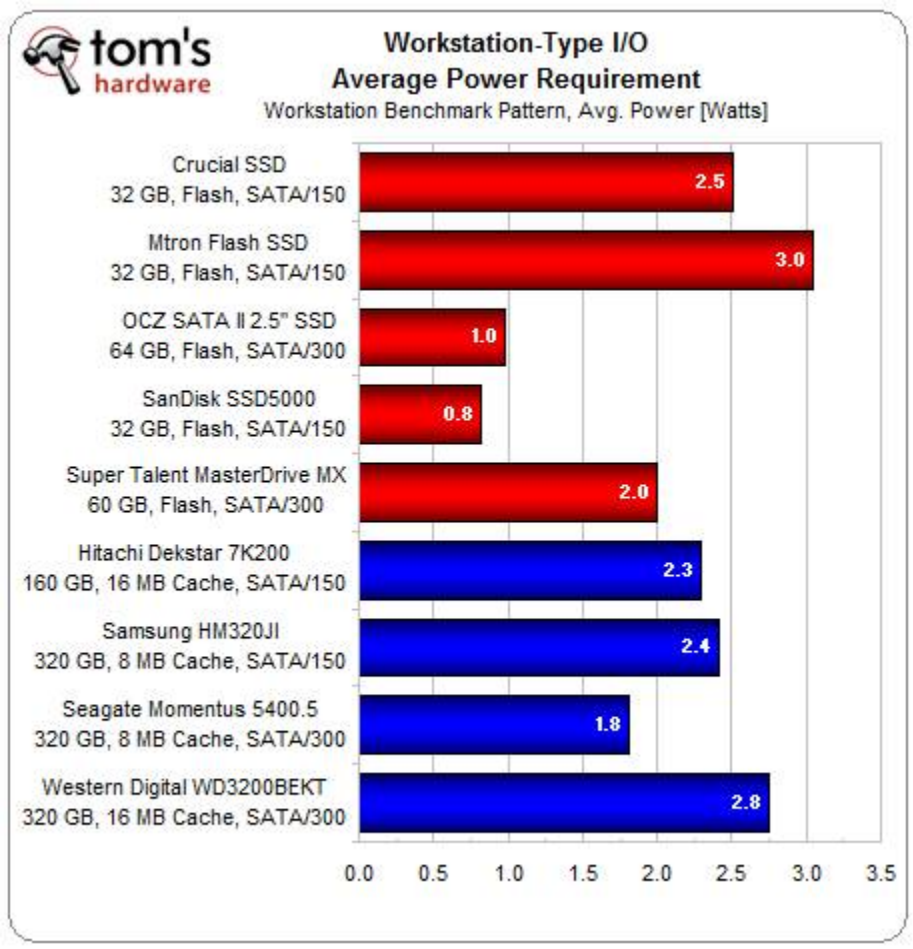
Typical Energy Consumption

	HDD WH/unit	SSD WH/unit
Design	360	150
Key Components		
Head	125	-
Disk	2000	-
Motor	900	-
SOC	170	-
Flash	-	200
Assembly & Test	3100	1000
Recycling	100K	100k

1 Horse power ~ 746 Watts
1 Watt Hour (WH) ~ 3600 Joules

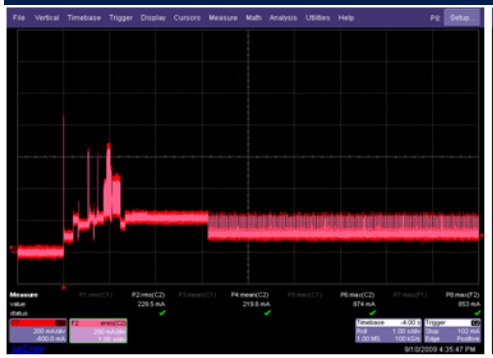
Workload Based Power Usage (1)

- Power consumption depends on workload and design



Measurement	SSD Value	HDD Value
Peak Spin-up Current (+5V)	853mA	786mA
Idle Power (W)	0.573 W	0.859 W
Write Power (W)	1.726 W	2.545 W
Read Power (W)	1.239 W	2.733 W
Operating Power (W)	1.249 W	1.860 W
Random Read Power (W)	0.653 W	2.401 W

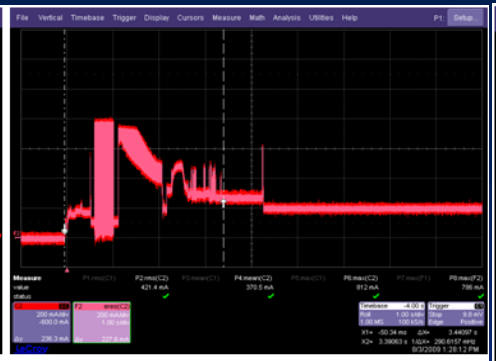
Workload Based Power Usage (2)



SSD

TTR=~1.3seconds

Peak = 853mA

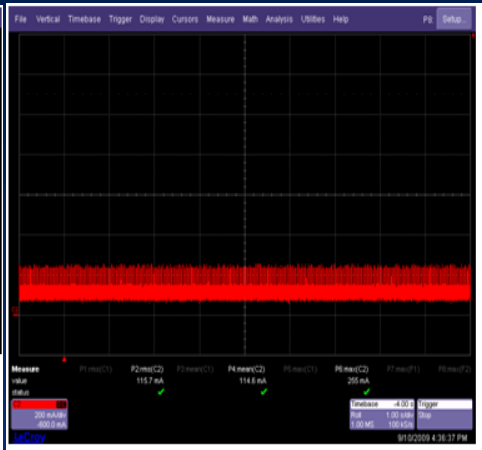


HDD

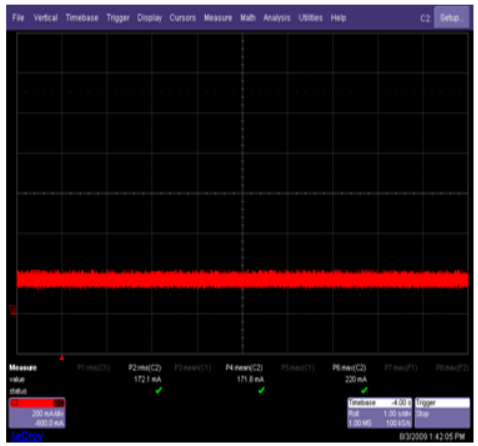
TTR = ~3.4seconds

Peak = 786mA

Spin up/Power On



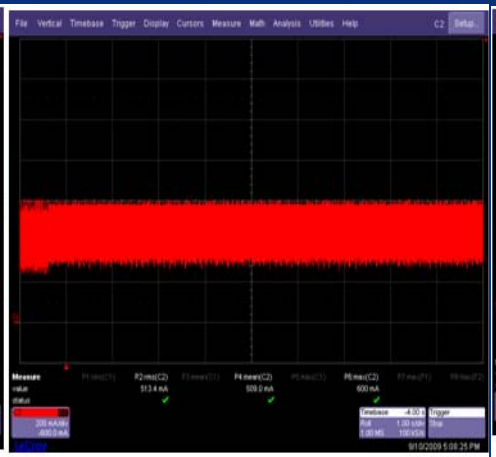
SSD



HDD

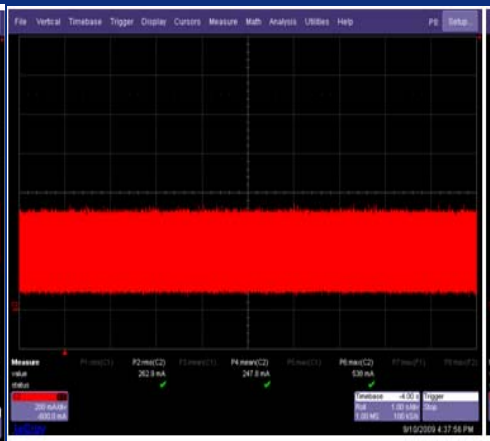
Idle Mode Power

SSD

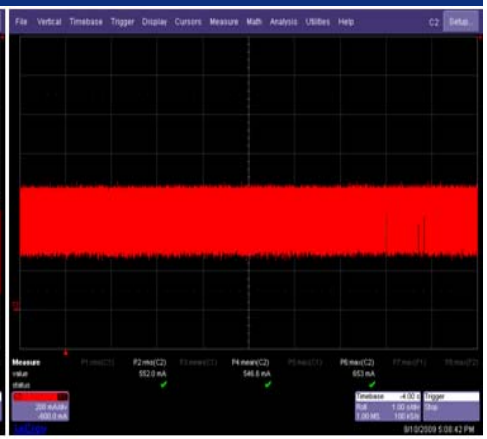


HDD

Write Mode Power



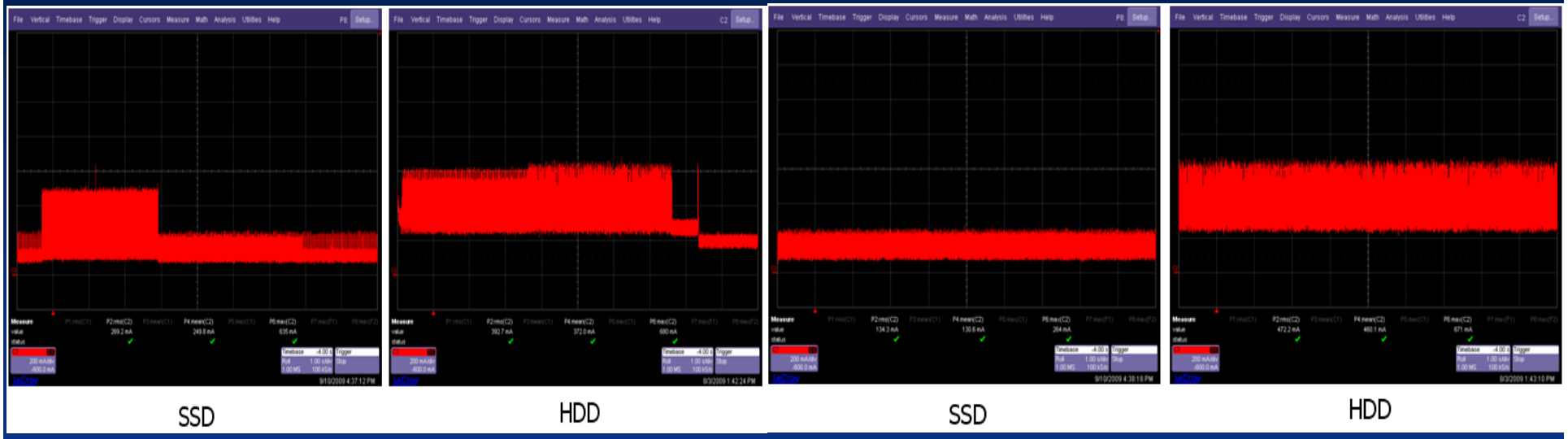
SSD



HDD

Read Mode Power

Workload Based Power Usage (3)



SSD HDD SSD HDD

Operating Mode Power

Random Read Mode Power

With high IOPS and parallel processing in SSD
- Average power usage is much lower for SSD
- Instantaneous current draw can be high in SSD
- Operational power consumption is lower for SSD

Directions for Energy Efficiency

- HDD
  - Typically ~10% of system power
  - Higher areal density
  - ASIC wafer process line width & logic voltage
  - Low operating voltage
  - Lower rpm, data rate – trade off with performance
  - Duty cycle management
  - Resistance reduction (fewer disks, smaller disks, lower IR drop)
- SSD
  - Typically 5% of system power
  - Flash line width (higher density) & logic voltage
  - Lower operating voltage
  - Management of instantaneous current
  - Fewer components on PCBA